Of grades, learning outcomes and soft skills cultivation in an engineering technology course with relation to learner type

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Abstract: - The present work examines the performance of a batch of undergraduate Civil Engineering Technology students who took the Soil Mechanics and Foundations core course, in relation with the preferred learning styles of the students. Focus of the study was on the assessment of group tasks, which parameters included academic performance (grades) and character building (soft skills). It was essentially to identify the congruence between learning styles and ‘soft’ and ‘hard’ learning effectiveness for the course via group tasks, i.e. Assignments, Lab Work and Project. In addition, attainment of the soft skills embedded in the tasks was determined from an end-of-course survey. It was found that the composition of learner types in a group has a significant impact on the outcomes of the group tasks, where a wider spectrum of learning styles among the group members appeared to produce more effective collaborative learning.

Key-Words: - Graduate Attributes, Job Market, Competencies, Soft Skills, Engineering Education, Learner Type

1 Introduction

In the delivery of an engineering technology education course, a balanced emphasis on theory and practical is necessary to ensure students are able to relate the two components. For these future technologists, competence in technical problem-solving skills should be substantiated with a sound fundamental knowledge of the subject as well the less emphasized ‘people skills’. Course contents aside, both the academic performance and character shaping are very much influenced by the learning styles preferred by the students.

This paper describes the group tasks incorporated in a core course of the undergraduate Civil Engineering Technology programme, i.e. Soil Mechanics and Foundations. The tasks of Assignments, Lab Work and Project were conducted throughout the 14-week semester in the same group setting. Students were permitted to form their own groups, though with specific instructions to avoid racial and gender segregation. At the end of the semester, a questionnaire was completed by the students to gauge their perception of the learning outcomes attainment and soft skills cultivation. Students also performed an online learning style profiling exercise to ascertain their respective learning preference. An analysis was then carried out to determine if there is a relationship between the performance of the students and their self-assessment in terms of learning outcomes attainment and soft skills development, as influenced by the collective learning style within the group.

2 Of learning style, grades and soft skills

Figure 1 shows the correlation between the tasks and learning outcomes. Each course is usually assigned 3 Course Learning Outcomes (CLOs), each corresponding with a specific Programme Learning Outcome (PLO). The related PLOs and CLOs are
given in Tables 1 and 2. Note that for the course, the group tasks only relate to CLOs 2 and 3 for the Project and Lab Work as well as Assignments respectively, while CLO2 correspond with PLO2 and CLO3 with PLO6. The grading system adopted at the University can be found in Table 3. The Assignments were aimed at training the students to identify and adopt relevant resources to address a given question or problem, supplementing and substantiating their understanding of a certain topic (CLO3). It led to the fulfillment of PLO6, where students develop the ability to seek information and solutions from various sources, engaging in lifelong learning in their respective career paths.

Table 1: PLOs of the programme

<table>
<thead>
<tr>
<th>PLO2</th>
<th>PLO3</th>
<th>PLO6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrate comprehensive technical expertise in the area of Civil Engineering Technology.</td>
<td>Communicate effectively both in written and spoken form with technologist, other professionals and the community</td>
<td>Recognize the need for, and to engage in life-long learning and professional development.</td>
</tr>
</tbody>
</table>

Table 2: CLOs of the course

<table>
<thead>
<tr>
<th>CLO1</th>
<th>CLO2</th>
<th>CLO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop effective course of action to address geotechnical, foundation and geo-environmental problems on site, based on stipulated standards and relevant principles. [PLO3-C5-Test &amp; Exam]</td>
<td>Organize comprehensive design and execution procedures for geotechnical as well as geoenvironmental solutions with practical considerations. [PLO2-P3-Project &amp; Labwork]</td>
<td>Adopt and use relevant resources on the fundamental mechanism of geotechnics and geo-environment to facilitate in-depth understanding. [PLO6-A3-Assignments]</td>
</tr>
</tbody>
</table>

Table 3: The Grading System at UTHM for undergraduate programme

<table>
<thead>
<tr>
<th>Marks</th>
<th>Grade</th>
<th>Achievements</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-100</td>
<td>A+</td>
<td>Excellent</td>
</tr>
<tr>
<td>80-84</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>75-79</td>
<td>A-</td>
<td></td>
</tr>
<tr>
<td>70-74</td>
<td>B+</td>
<td>Good</td>
</tr>
<tr>
<td>65-69</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>60-64</td>
<td>B-</td>
<td></td>
</tr>
<tr>
<td>55-59</td>
<td>C+</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>50-54</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>45-49</td>
<td>C-</td>
<td></td>
</tr>
<tr>
<td>40-44</td>
<td>D</td>
<td>Poor</td>
</tr>
<tr>
<td>00-39</td>
<td>E</td>
<td>Fail</td>
</tr>
</tbody>
</table>
As illustrated in Figure 1, the group tasks do not only equip the students with technical knowledge and skills, but cultivate their soft skills to become charismatic, learned graduate technologists (Figure 2). The learning process, however, is influenced by the learning styles of the students, if not predominated by them. The learning styles were determined through an online survey was developed by Felder and Silverman [1], with emphasis on the key learning processes of reception and processing. Students are essentially classified according to their preferred manner of receiving and processing taught materials and other related information. The model consists of 4 pairs of opposing learning dimensions encompassing the key learning styles:

1. Preference of information perception: **sensory** (sights, sounds, physical sensations) vs. **intuitive** (possibilities, insights, hunches)
2. Preference of sensory channel to receive information: **visual** (pictures, diagrams, graphs, demonstrations) vs. **verbal** (words, sounds, music)
3. Preference of information processing method: **active** (through physical activities or discourses) vs. **reflective** (through introspection)
4. Progress towards understanding: **sequential** (in steps) vs. **global** (in leaps, holistically)

### Communication Skills

### Critical Thinking and Problem Solving Skills

### Team working Skills

### Life-long Learning and Information Management Skills

### Entrepreneurship Skills

### Ethics and Professionalism Skills

### Leadership Skills

**Figure 2: Soft Skills**

In groups of 4-5 students, a diversified learner profile is inevitable as the group members hail from varied socio-cultural backgrounds and settings [2]. The mismatch between the learning styles and the teaching methods would result in ineffective delivery of course contents, and risk affecting the motivation to learn [3]. It was further postulated by Sampson and Karagiannidis [4] and Brown [5] that learners experience greater motivation and efficiency when working in an environment which suits their learning preference. Corroborating with these findings, Pask [6] showed students to learn more effectively if the teaching materials are delivered in manners preferable to their learning styles. Helping students to identify their preferred learning method and make adjustments to suit the learning environment can also result in better attainment of the learning outcomes [e.g. 7, 8 & 9].

### 3 Results and Discussions

The PEOs of engineering programmes are typically limited to 3, with emphasis on the key aspects of technical knowhow, problem-solving skills, research and social obligations (Table 1). All the programmes have however coincidently designed the PEOs to focus on knowledge and skills in the first objective, followed by emphasis on the development of soft skills in the second and third objectives. This alignment acknowledges the importance of simultaneous cultivation of the students’ employability and technical competence. Indeed, it would appear as if students are engaged in equal, if not more character-building exercises than technical enhancement activities. Nonetheless these objectives are not expected to be measurable until 3-5 years after graduation, which make the assessment possible only via long term tracer studies.

#### 3.1 Data collection

As mentioned earlier, the data presented in this paper were obtained via an end-of-course survey among the students. The questionnaire encompassed students’ views on the attainment of Course Learning Outcomes, Programme Learning Outcomes as well as the soft skill set. Only response related to the group tasks, i.e. Assignments, Project and Lab Work, were analysed and discussed presently. Note that the same group formation (total of 18) was engaged in all the activities. Students also completed the online learning style survey “Index of Learning Styles Questionnaire” (http://www.engr.ncsu.edu/learningstyles/ilsweb.html) based on the Felder-Silverman model (Felder and Silverman, 1988) to identify their respective preffered modes of learning. In order to distinguish the correlations between the parameters examined, the best, middle and lowest ranked groups were highlighted in each task to find the thread that relates them all.
3.2 Assignments

A total of 3 Assignments were completed by the students throughout the semester, where each Assignment covered a particular topic being delivered in class at the time. The task generally required students to search for information beyond the lecture notes, process and understand the underlying principles, finally to summarize and compile the gathered data in a single-page mind-mapping presentation. Students were given a week to complete the task. Most submissions were found to contain creative illustrations and sketches, with demonstration of connectivity between the new ideas / knowledge gained with what was taught in class. Undeniably students rely heavily on internet resources, but guidance was given to sieve through the information for useful, relevant data and to refer to technical writings like textbooks, journal and conference papers for verification.

The grades for Assignments were found to be in the ascending order of Group D2-3 (A-) < B1-2 (A) < D1-3 (A+). Students’ perception on the attainment of the learning outcomes (both PLO and CLO) did not seem to reflect the group’s performance in the task (Figure 3). PLO6 was considered significantly achieved by ≥50 % for all groups, while 1/4 of Group D2-3 thought that CLO3 was barely achieved (L = 25 %). This coincided with the poorest performance of the group, suggesting possible difficulties faced by the group in searching, identifying, sorting and compiling relevant information for the Assignments.

Soft skills wise, communication skills, team working, leadership, entrepreneurship, critical thinking and problem solving as well as lifelong learning were generally reported to be cultivated among all the groups. Nonetheless only the best ranked D1-3 reckoned ethics and professionalism important attributes developed in the process of preparing the Assignments. Taking into account that students were repeatedly reminded to not go down the futile path of ‘copy-and-paste’ strategy, D1-3 appeared to have adopted the no-cheating attitude in performing the task: a commendable positive learning attitude indeed in the age of easily accessible digital data.

From the learning style perspective, all groups were found to be dominantly visual learners, though B1-2 and D1-3 also favoured the reflective and global learning approached respectively (Figure 3). Both groups showed a good mix of learner types too, though the substantial number of global learners in D1-3 could have given the group an edge, by providing a bird’s eye perspective in effectively adjoining the facts gathered for the Assignments in a coherent manner. The fact that these 2 groups fared better is suggestive of the benefits of having a mixture of learner types in a collective effort to complete the task.

<table>
<thead>
<tr>
<th></th>
<th>Top Group D1-3</th>
<th>Middle Group B1-2</th>
<th>Lowest Group D2-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLO6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLO3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 3: Assignments- LOs and learning styles
3.3 Project

Each group was assigned a Project which was conducted throughout the 14-week semester, culminating in the presentation in the form of a mini exhibition. Each group was assessed by a pair of panellists from the related fields, in the main components of technical report, model or visual aids and presentation skills. Overall students showed great enthusiasm in learning beyond the lectures, and commendable resilience against the pressure built up with the looming deadline.

Referring to Figure 4, the students' performance in the Project follows the ascending order of Group A2-1 (C+) < B2-3 (A-) < A1-2 (A+). On the perception of attainment levels in the related PLO and CLO, A1-2 with the best performance showed remarkable attainment of both PLO2 and CLO2 (i.e. the corresponding learning outcomes for Project), with 60% agreeing to significant fulfilment of the intended outcomes. Group B2-3 and A2-1, on the other hand, recorded moderate attainment of both learning outcomes, though at fairly good percentages of 50% and above. A little puzzling is the fact that while 60% group members of A1-2 (lowest ranked group) reckoned the Project helped them to achieve PLO2 at significant level, the performance appeared to be sub-par. This could indicate the possibility of misguided perception on what the students really learned and what teachers assumed the students to have learned from the grades alone.

Soft skills like entrepreneurship, critical thinking and problem solving emerged as the common learning outcomes among the groups, though the level of attainment varied (Figure 4). Interestingly, only the lowest ranked group did not count team working as an attribute cultivated in performing the task. Perhaps this was the reason for the poor grades obtained for the task, i.e. lack of coordination and working together for a multi-facade task as the Project. In addition, the best group associated the task with honing their skills in lifelong learning and information management, highlighting the group’s resourcefulness in gathering information and data for the Project. The particular skill set, coupled with the problem solving skill mentioned earlier (which was also rated significantly achieved by the group), engaged students in searching, reviewing and organising useful pieces of materials to formulate the answers and solutions to a given problem.

The learner type composition of the respective groups suggests combined styles to be expedient in producing excellent designs and solutions for the Project, i.e. A2-1. While the poorest group (A1-2) showed dominance in more than one learning style (i.e. visual and action) compared to the other groups, the lack of variety in learning styles proved to be an overwhelming disadvantage. B2-3 in particular exemplifies the fact that dominance in 1 or 2 learning styles cannot compensate for the lack of variety in a group effort such as doing a Project. This is in agreement with the findings in Assignments, where combined learning preferences tend to steer the group better towards achieving good grades.
3.4 Lab Work

The Lab Work session included basic experiments and a number of practical problem solving scenarios. Students were required to carry out the experiments in accordance with standard procedures and perform analysis of the test results to reach some coherent conclusions. The practical scenarios present on site problems with relevance to the parameters examined in the experiments, thus guiding the students to comprehension of the link between theory, experiments and actual field conditions.

The students’ performance in Lab Work is summarised in Figure 5, with Group A1-2 (A-) leading E2-2 (C+) and D2-3 (C). Overall all groups concurred on the attainment of the learning outcomes, PLO2 and CLO2. It is interesting to note that both the best and lowest ranked groups largely found the learning outcomes to be significantly attained via Lab Work, though the grades obtained were rather different. This again implies the occasional incompatibility between students’ self recognition of what they have learned and achieved, and the grades they made in a particular task.

All groups acknowledged team working to be vital for completion of the Lab Work, complemented by other skill sets like communication skills, critical thinking and problem solving. Entrepreneurship was also reported be moderately achieved in the lab sessions. This is most probably referring to the end-of-experiment questions regarding alternative solutions for problems on site with emphasis on the practicality and economics.

The learning style profile was predominantly visual for both Groups D2-3 and E2-2, with only A1-2 having equal share of learners with visual and action preferences. Apparently for practical session as the Lab Work, students tended to learn more effectively with explanation of the test procedure accompanied by demonstration of how the tests were conducted beforehand. The lack of sequential-oriented learners, combined with the shortage of other learner types in the lowest ranked group clearly affected the overall grades in this task.

<table>
<thead>
<tr>
<th></th>
<th>Top Group A1-2</th>
<th>Middle Group E2-2</th>
<th>Lowest Group D2-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLO2</td>
<td><img src="chart1.png" alt="Chart" /></td>
<td><img src="chart2.png" alt="Chart" /></td>
<td><img src="chart3.png" alt="Chart" /></td>
</tr>
<tr>
<td>CLO2</td>
<td><img src="chart1.png" alt="Chart" /></td>
<td><img src="chart2.png" alt="Chart" /></td>
<td><img src="chart3.png" alt="Chart" /></td>
</tr>
</tbody>
</table>

Learning Styles

Figure 4: Labwork- LOs and learning styles
7 Conclusions

- An assortment of learner types is expedient in completing the group tasks, with most soft skills cultivated in the exercise and a fairly good attainment of the learning outcomes perceived by the students.
- The team working setting could be enhanced with the different learning preferences of the group members, leading to a more comprehensive approach to produce a good piece of homework.
- Grades do not necessarily reflect the attainment of learning outcomes, as shown in several instances where the lowest ranked groups perceive themselves to have better fulfilled the intended outcomes than the groups that performed better.
- Better engagement could also be established with the students in practical sessions by providing step-by-step demonstration before the students conduct the experiments themselves.
- Generally the development of soft skills was very much facilitated by group efforts, through active participation of group members with different learning preferences and background.
- In short, learner types apparently have an influence on the grades achieved in the group tasks, where the soft skills cultivated appeared to be more pronounced in the high-achiever groups too.
- The overall findings bag the question of whether or not students should be allowed to from their own groups or if lecturers should assign group formation based on a prior learning style profiling exercise. The present study seemed to indicate the latter, though that could deprive students of the opportunity to learn taking charge of their learning, and perhaps inadvertently raise the risk of incompatibility among group members leading to poor performance. For certain, in a large class of over 30 students, peer-supported learning in group tasks could help engage students in a successful and enriched learning process.

Acknowledgement
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References